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# A review of pharmacology, toxicology and phytochemical composition of *Cassipourea malosana* (Rhizophoraceae)

Dennis Jack Opwoko, Joseph Mwanzia Nguta, Isaac Ole Mapenay

## ABSTRACT

Plants have served as a rich source of bioactive compounds leading to their utilization in folk medicine for a variety of diseases. Plants have also been explored in development of synthetic drugs. In contrast to plants benefit in management of various conditions, they have toxic compounds and the safety of these plants is not extensively analysed for toxicity profile. In addition, the mechanism of action, pharmacokinetics, bioavailability, synergistic effects and clinical validation data on plants are still under-researched. This review article explores the pharmacology, toxicology and phytochemical composition of *Cassipourea malosana* (Rhizophoraceae) documented in manifold journals and articles. This review article has been created with the assistance of articles, books, peer reviewed articles, validated internet sources, theses, Science Direct and Google Scholar. *Cassipourea malosana* (Rhizophoraceae) has been employed in treatment of various disease like: stomach ailments, wound healing, treatment of fever and relieve of headache. Hence, these uses can be attributed to diversity of phytochemical constituents including but not limited to tannins, alkaloids, flavonoids and saponins. *Cassipourea malosana* (Rhizophoraceae) pharmacology and toxicology have not been extensively studied. Further studies are needed to demonstrate additional phytochemical constituents, pharmacological activities and toxicity profiles. *Cassipourea malosana* (Rhizophoraceae) will provide new medication in the management of diseases to supplement conventional drugs which have been linked to various adverse effects during their use.

**Keywords:** Rhizophoraceae, *Cassipourea malosana*, Pharmacology, Phytochemical composition, Phytochemical toxicity.

## INTRODUCTION

Several manuscripts including but not limited to Chinese writings, Unani, and Egyptian papyrus have documented the use of plants for medicinal value since ancient times [1]. There is a surge in the sales of botanicals with the aim of disease prophylaxis, treatment and maintenance of good health [2, 3]. These botanicals include: dietary supplements, foods and herbal medicines. Botanicals contain various chemical constituents derived from the soil, different growing conditions, weather or climatic variations, variation in harvesting, processing or manufacturing, solvents or excipients used in formulation and methods of storage. These differences may present a discrepancy in chemical composition that may subsequently impact on the efficacy and the safety of the final products. These have led multidisciplinary collaboration to implementation of regulatory safety requirements and testing for botanicals to ensure their safety globally [3].

In developed countries, the population that utilizes herbal medicine on a regular basis is between 10% and 50% as per the World Health Organization (WHO). This is attributed to the global increase in the use of herbal plants as complementary and alternative medicine (CAM) and commercialization of medicinal plants and their metabolites by pharmaceutical industry formulating capsules, tablets and syrups. These reflects significance of medicinal plants in the market hence, in cooperation in treatment protocols, triggering research to ascertain their efficacy and toxicity profile. Worldwide, people have been convinced that natural compounds are less toxic than the conventional drugs because they are of natural origin. However, medicinal plants have phytochemical constituents that may interact pharmacologically with different chemicals to produce synergistic or adverse effects [4].

Plants still find their use in conventional structures of practice of medicine due to emergence of resistance to conventional drugs currently used in therapy, side effects of the currently prescribed medication, exorbitant treatment costs, inadequate drugs at healthcare facilities and the ever-rising population. The upsurge in drug resistance by micro-organisms has led to paradigm shift to medicinal plants for development of plant-based products for utilization in therapy [1]. Although medicinal plants have been utilized in traditional medicine practices for centuries, the only way to validate their safety and efficacy is by carrying out biological assays to ascertain their appropriate doses in management of various diseases without causing toxicity as per the objectives of the World health Organization Traditional Medicine Strategy [5]. Therefore, the need to research on the phytochemical composition and toxicity of medicinal plants.

Toxic compounds from plants can alter the vital functions of the body systems. The major toxic substances are neurotoxins which affect the nervous system majorly altering the central nervous system, the second major toxins being the cytotoxins and the third dominant toxin being metabolic toxic substances which impair the functions of organs like: heart, kidneys lungs and liver. The magnitude of the effect is determined with the growth stage, species, part of the plant consumed, frequency of poisoning or intoxication, route of administration, solubility in body fluids, age and the susceptibility of the causality. Majority of the toxic compounds that function as defence chemical constituents possess medicinal characteristics at lower concentrations. The extreme toxic constituents comprise of: cardiac glycosides, cyanogenic glycosides, lectins, alkaloids and phorbol esters. These toxic compounds have been utilized by man for decades for several purposes like healing, abortions, war, hunting, rituals, divination traditions, euthanasia and suicide Unfortunately, only a small fraction of the toxic plants have been studied and documented [3].

*Cassipourea malosana* (Baker Alston) with the common name of Onion wood has been documented among the most common medicinal plant species in the wetlands of Kenya [6]. This review seeks to record the phytochemical constituents, pharmacology and toxicity of *Cassipourea malosana* (Rhizophoraceae). However, the data on scientific studies to reveal the pharmacology, toxicology and phytochemical composition of the *Cassipourea malosana* (Rhizophoraceae) is not available.

This review aims to determine if *Cassipourea malosana* (Rhizophoraceae) is a valuable lead compound for therapeutic development of investigational drug and if the phytochemical constituents of *Cassipourea malosana* (Rhizophoraceae) are potential antimicrobial agents to overcome antimicrobial resistance. Additionally, this review provides comprehensive overview of published data regarding pharmacology, toxicology and phytochemical composition of *Cassipourea malosana* (Rhizophoraceae). Therefore, the current review will provide empirical data that will be analyzed to rationalize the use of the extracts from the plant to treat bacterial infections, evaluation of safety and chemical components of *Cassipourea malosana* (Rhizophoraceae).

## METHODOLOGY

This review article has been created with the assistance of articles, books, peer reviewed articles, validated internet sources, theses, Science Direct and Google Scholar. The search phrases included: pharmacology of *Cassipourea malosana*, toxicology of *Cassipourea malosana* and phytochemistry of *Cassipourea malosana*. The articles published from years 1956 to 2024 were considered in the review. The older literatures were valuable in the search for pharmacological activity of *Cassipourea malosana*. Relevant articles were accessed using inclusion and exclusion criteria.

## PHYLOGENY

*Cassipourea malosana* description, Taxonomy, distribution and morphology of *Cassipourea malosana* (Rhizophoraceae).

### Botanic Description

**Table 1:** Botanical description of *Cassipourea malosana* [7,8]

| S. No. | Plant/ Plant parts | Plant /Plant parts Description |
|---|---|---|
| 1 | *Cassipourea malosana* tree | • Is an evergreen tree<br>• Is approximately 6-45 m in height |
| 2 | Trunk/Stem | • Is pale<br>• Is noticeably straight<br>• Is cylindrical<br>• It has a small rounded crown |
| 3 | Branches | • Radiate out at right angle to the trunk |
| 4 | Bark | • Is pale grey with well-defined ring marks<br>• Is smooth<br>• Has horizontal lines.<br>• Has slash soft, pale orange darker outer edge |
| 5 | Leaves | • Are dark-green<br>• Are opposite<br>• Are 5 x 3 cm, but variable in size<br>• Are glossy<br>• Are oval in shape<br>• Are tough<br>• Are borne woody twigs<br>• Margins are toothed or entire |
| 6 | Flowers | • Are 1-5(-8) per inflorescence<br>• Are laterally placed under leaves<br>• Pedicels measure up to 4 mm, rarely 7 mm long<br>• Are densely puberulous<br>• Are yellow-green.<br>• Calyx 4-5-partite<br>• Tube 1 mm long<br>• Lobes are 3.5-5 mm long and narrowly oblong-triangular<br>• Apex acute, densely appressed-pubescent externally, glabrous or very nearly so within<br>• Petals 4-5 laciniate apically, anthers introrse<br>• Ovary superior, 3-4 celled, glabrous or almost so with a few apical hairs. |
| 7 | Fruits | • Are thin fleshy dehiscent capsule<br>• Are small<br>• Are egg-shaped.<br>• Are 1 cm long, becoming black when dry |

The species is quite variable with regard to leaf morphology. The specific epithet malosana is named after Mt. Malosa in Malawi where the specimen was collected [8].

The North East African material of this species: *C. abyssinica*, *C. avettae* and *C. salvago-raggei*, shows a tendency to include specimens with narrower more acuminate leaves. Kenya material is usually small-leaved (terminal sprigs may bear leaves up to only 4–5 mm. long), the leaves having scarcely any acumen. These differences are not absolute however and the variation in the degree of serration of the leaf margin is not correlated with them [9].

**Figure 1:** *Cassipourea malosana*

**Figure 2:** Images of parts of *Cassipourea malosana* (https://www.inaturalist.org/observations/243843767)

## Ecology

*C. malosana* is a tree commonly found in moist montane forest in association with Podocarpus spp. It also occurs in upland dry forest. [8].

## Biophysical Limits

Altitude: 750-2 550 m Mean annual rainfall: over 2 200 mm [8].

## Documented Species Distribution

Native: Kenya, Ethiopia, Eritrea, Malawi, Mozambique, Zimbabwe, KwaZulu-Natal, Zambia, Rwanda, Somalia, Swaziland, Sudan, Tanzania, Mozambique, Cape Provinces, Northern Provinces, Burundi, Uganda, Cameroon, Malawi, Zaïrea and Eastern DR Congo [8, 11-13].

In Kenya *Cassipourea malosana* is found in the following regions: Katimok forest in Baringo District, Chania Forest in Kiambu District, Thika District, Ngong Forest in Masai District and Kirisia State Forest in Samburu District, northern Kenya [9, 14,15].

## Distribution


**Figure 3:** A map showing the native and exotic range of *Cassipourea malosana* [8]

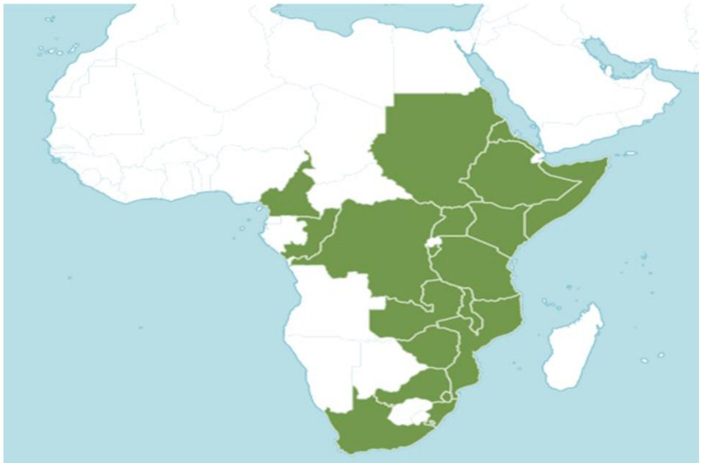

**Figure 4:** A map showing the native African countries of *Cassipourea malosana* (Rhizophoraceae) [13]

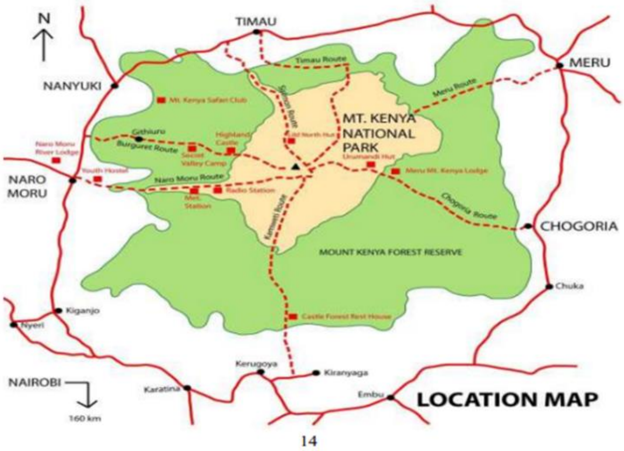


**Figure 5:** A map indicating the location of Mount Kenya (https://www.mountkenyaclimbing.com) [16]

In Kenya, *Cassipourea malosana* (Rhizophoraceae) is also found in Mount Kenya forest among other trees like bamboo, *Juniperus procera* and *Podocarpus milanjianus* [16]. In Northern part of Kenya, in Marsabit county, is located Chalbi desert which is a green island with a tropical rainforest with diverse of mountains covered with evergreen forest with tree species that include but not limited to *Cassipourea malosana, Juniperus procera, Podocarus gracilior, Croton megalocarpus,* and *Olea africana* [17].

In Montane Forest located in Mount Kilimanjaro, the forest covers an area of more than 282 square kilometres, extending from the lower to the middle regions of the forest. *Cassipourea malosana* trees (Pillar Wood) are located in the region which is between 1,600 and 2,500 meters above the sea level on the northern, eastern and western part of the slopes of Mount Kilimanjaro [18].

## Morphology of Rhizophoraceae

Rhizophoraceae has four mangrove and ten inland genera. The seeds are winged and arillate in a fruit that is capsular. The indehiscent hard-walled capsule contains non-appendage seeds. There exist some minor differences in the morphology of the seeds from the various genera but the seed coats are defined as undifferentiated, exotestal or exotestal-exotegmic. The morphology of the seeds and reproductive characteristics are related to the different families and help in the classification of the Rhizophoraceae. Eleven species of *Cassipourea* (Rhizophoraceae) have been document in Gabon [19, 20].

## Taxonomy

**Table 2:** Taxonomy of *Cassipourea malosana*

| | |
|---|---|
| **Kingdom:** | **Plantae** |
| **Phylum:** | Tracheophyte (Angiosperms) |
| **Class:** | Magnoliopsida |
| **Order:** | Malpighiales |
| **Family:** | Rhizophoraceae |
| **Genus:** | *Cassipourea* Aubl. |
| **Variety:** | *Cassipourea malosana* (Baker) Alston |

### Traditional Names

Several literatures have documented the traditional names, English name and trade name of *Cassipourea malosana* (Rhizophoraceae) as outline in Table 3.

**Table 3:** Different names of *Cassipourea malosana* [7,8,11,21-25]

| Source of name/ Country | Name |
|---|---|
| English | Pillarwood, common onion wood, bastard onion wood |
| Trade name (East Africa) | Ndiri, Muzaizi, Msengera |
| Eastern Cape and KwaZulu-Natal provinces (IsiXhosa and IsiZulu) | Ummemezi |
| Oromo (Eastern Ethiopia) | Lalessa, Lookoo |
| Sidama (Loka Abaya- Ethiopia) | Kincho |
| Tigrigna (Southrn Tigray-Ethiopia) | Tselim om, Muka Dadi |
| Central Kenya (Kikuyu) | Muthathi |
| Kenya (Maasai) | Olarioi |

## PHYTOMEDICINAL VALUE OF THE PLANT

### Ethnomedical uses, phytochemistry and biological properties of *Cassipourea malosana* (Rhizophoraceae)

In Central regions of Kenya, the kikuyu community use *Cassipourea malosana* (Baker) Alston (Rhizophoraceae) tree for the treatment of malarial [24].

In Eastern Ethiopia, in Fedis district, *Cassipourea malosana* (Rhizophoraceae) the root of the herb has been used ethnobotanically for treatment of intestinal parasites while the stem and the leaves of the shrub have been utilized in the management of pneumonia [25]. In south-eastern Ethiopia, *Cassipourea malosana* the fresh roots are Concocted and decocted then administered via the dermal route for treatment of cold (Qora) and fresh twigs are used for the management of rheumatism. The fresh leaves are concocted, they are crushed and decocted to be administered via the dermal route to manage rheumatism [26].

In the Northern regions of Maputaland in South Africa, *Cassipourea malosana* aqueous combination with *Hypoxis hemerocallidea* to treat gonorrhoea infection. It is prepared by measuring two litres of water, which are used to boil the bark of *Cassipourea malosana* with *Hypoxis hemerocallidea*. Then the concoction is taken orally at a dose of half a cup twice daily [27].

The aqueous preparation of the leaves of *Cassipourea malosana* are mixed with the corm of *Hypoxis hemerocallidea* have been used In the Northern regions of Maputaland in South Africa for the inhibition of the following micro-organisms: Gram – negative bacteria *Neisseria gonorrhoeae* (diplococcus); *Ureaplasma urealyticum* (Mycoplasmataceae) and dimorphic fungus, *Candida albicans* [27].

The documented medicinal plants in Northern regions of Malawi shows that the relative importance (RV) values of *Cassipourea malosana* (Baker) Alston is 0.20, use value (UV) of 0.03, informant agreement ratio (IAR) of 1, and relative frequency of citation (RCF) of 0.05 amongst the plants used in the management of infectious diseases. *Cassipourea malosana* (Baker) Alston (Rhizophoraceae) roots are cut and dried. They are pound to form a powder which is mixed with *Bauhinia thonningii* and *Steganotaenia araliacea* then the mixture is soaked in water, filtered and administered with either one to two teaspoonfuls of honey or milk. Half a cup of the mixture is taken orally for the treatment of intestinal helminths or worms [28].

*Cassipourea* species have been used cosmetically for sun protection and in the treatment of hypermelanosis by women in KwaZulu -Natal and Eastern Cape Provinces. These uses have been accredited to the anti-tyrosinase actions leading to skin-lightening. The bark of the stem is grinded and mixed with water to produce a paste which is applied on the faces of black women for the enhancement of beauty to lighten the skin tone, eradicate blemishes and to improve the skin complexion. Both the bark and the roots of the plant are used for skin lightening [23,29].

*Cassipourea malosana* (Rhizophoraceae) metabolites have been documented for their utilization in the management of melasma, which is a common skin disorder that presents as dark spots or patches on the skin. This has been attributed to the metabolites acting through both the intracellular estrogen receptor 1 and the intracellular estrogen receptor 2 [30]. The anthocyanin obtained from *Cassipourea malosana* is used for lightening the skin [31].

*Cassipourea malosana* (Rhizophoraceae) outer bark is mixed with water, boiled and combined with soup, which is then taken to gain strength among the Loita Maasai community in Kenya. While the inner section of the bark is scrapped and used to prepare tea which is given to women to aid the removal of the placenta during delivery. The bark is used in South Africa to manage sunburns and skin disorders. The bark of *Cassipourea malosana* has been utilized in the management of malaria and the root has been prepared in a decoction and used topically for the treatment of rheumatic disorders [32].

## PHYTOCHEMISTRY

Liquid Chromatography-Mass Spectrometry (LC-MS/MS) assay on *Cassipourea* species has isolated phenolic acids, alkaloids, steroids, fatty acids, organosulphur compounds like: Guinesine B & C, gerradine, sulphur containing amides such as: euphane, *Cassipourea*mide A & B, di and tri-terpenoids like: monocyclic diterpenoids and lupine type triterpenoids, flavonoids such as: flavonol glycoside, bioflavonoids and flavonols, from the stem bark extracts [23,29]. *Cassipourea malosana* contains intermediate metabolite hydroquinone obtained from the dimeric anthocyanins when treated with sodium carbonate [31].

The phytochemical constituents isolated from the root of *Cassipourea malosana* (Rhizophoraceae) include but not limited to: stigmast-5-en-3-O-*β*-*D*-glucoside; (-)-syringaresinol; 7-methoxygeranin A; 7-methoxymahuannin B; methyl-3-(4-hydroxy-3-methoxyphenyl)-2*E*-propenoate,glycerol-1-alkanoate, (*E*)-3-(4-hydroxy-3-methoxyphenyl) prop-2-enal; proanthocyanidins: mahuannin B; and two cycloartane triterpenoids: 24-methylenecycloartan-3*β*,26,30-triol and 26-hydroxy-3-keto-24-methylenecycloartan-30-oic acid [29].

Field study on the bark of *Cassipourea malosana* and other three species of *Cassipourea* namely: *C. celastroides, C. gummiflua* and *C. euryoides* using detective indicator ($PdCl_2$) has shown that their barks contain sulfur constituents and alkaloids like pyrrolizidine which contains: isocassipourine and bisdisulphide bridge, while pyrrolidine which contains 1, 2-dithiolane ring system [33]. Phytochemical composition of *Cassipourea malosana* are given in Table 4.

**Table 4:** Phytochemical composition of *Cassipourea malosana* [23,29,31,33]

| Phytochemical constituents | Reference |
|---|---|
| Alkaloids | [23, 29] |
| Flavonoids | [23, 29] |
| Organosulphur compounds | [23, 29] |
| Phenolic acids | [23, 29] |
| Steroids | [23, 29] |
| Terpenoids | [23, 29] |
| Sulphur containing amides | [23, 29] |
| Guinesine B & C | [23, 29] |
| Gerradine | [23, 29] |
| Euphane | [23, 29] |
| *Cassipourea*mide A & B | [23, 29] |
| di and tri-terpenoids | [23, 29] |
| monocyclic diterpenoids | [23, 29] |
| lupine type triterpenoids | [23, 29] |
| flavonol glycoside | [23, 29] |
| bioflavonoids | [23, 29] |
| Flavonols | [23, 29] |
| hydroquinone | [31] |
| stigmast-5-en-3-O-*β*-*D*-glucoside | [29] |
| (-)-syringaresinol | [29] |
| 7-methoxygeranin A | [29] |
| 7-methoxymahuannin B | [29] |
| methyl-3-(4-hydroxy-3-methoxyphenyl)-2*E*-propenoate, glycerol-1-alkanoate, (*E*)-3-(4-hydroxy-3-methoxyphenyl) prop-2-enal | [29] |
| proanthocyanidins | [29] |
| mahuannin B | [29] |
| cycloartane triterpenoids | [29] |
| 24-methylenecycloartan-3*β*,26,30-triol | [29] |
| 26-hydroxy-3-keto-24-methylenecycloartan-30-oic acid | [29] |
| Pyrrolizidine | [31] |
| isocassipourine | [31] |
| pyrrolidine | [31] |

## BIOLOGICAL PROPERTIES

Medicinal plants or medicinal herbs provide a reliable source of phytochemicals or bioactive constituents such as immune-potentiating agents, detoxifiers, neuropharmacological agents, antioxidants, dietary fibre, and anticancer agents utilized in management of various diseases like: cancer, coronary heart disease, diabetes and infectious diseases [1]. Some of the medicinal plants commonly used in therapy are not regulated. Therefore, they have prospective genotoxic effects on long term use and have a risk of misadministration [34].

Biological activities of medicinal plants have been tested using various assays, starting with the in vitro assays then followed by in vivo assays for plant products with promising activity from the fractioned or crude extracts. The activities screened from the crude extracts include: antibacterial activities, antioxidant properties, anti-inflammatory activities, anti-amoebic activities, antimalarial properties, anthelmintic activities, neurotropic properties, psychotropic properties for synergistic activities and antagonistic properties among the compounds of the crude extracts [34].

### Phenols

Phenolic acids are the leading among the phytochemical compositions with promising and well-known benefits. Phenolic acid refers to a group of compounds that have an aromatic ring containing hydroxyl (phenolic ring) and carboxyl groups. They are found in plants especially in fruits and vegetables, and they are also synthesized through the shikimate pathway from phenylalanine or tyrosine as secondary metabolite [35,36]. Phenolic acids have a protective role in plants by preventing the actions abiotic stresses like pathogen attack or predator attack and protection against ultra violet light. In humans, phenolic acids are used to manage several diseases such as bacterial infections, viral infections, fungal infections, protozoal infections, inflammation, diabetes and cancer [36]. Antibacterial activities and toxicity of phenols is due to increase in hydroxylation of phenols. The mode of action of phenols is by microbial enzymes interaction with sulfhydryl groups causing inhibition of the microbial enzymes or nonspecific interactions of proteins. Plant extracts containing phenols have ethnomedical utilization for management of bacterial infections [37]. Phenols as secondary metabolites have several roles in plants that include: preventing loss of moisture, signal transduction, structural support, prevention of encroachment by pathogens, antifeedant activities, antimitotic activities, antiviral properties, antifungal properties, antibacterial properties, antioxidant properties, protection against excessive exposure to sun, heavy metals and injuries [38,39].

### Flavonoids

Flavonoids have phenolic structures and are found in various parts of plants like: bark, stems, fruits, flowers and roots. Flavonoids are also found in vegetables, wine, tea and grains. Flavonoids find there use in pharmaceutical, nutraceutical, medicinal and cosmetic due to their anti-inflammatory properties, anti-oxidative activities, anticarcinogenic activities and antimutagenic properties. These activities can be attributed to modulation of cellular enzymes functions such as inhibition of xanthine oxidase (XO), lipoxygenase, phosphoinositide 3-kinase, cyclo-oxygenase (COX), cholinesterase (ChE), butyrylcholinesterae (BChE), aromatase, 17β-HSD, 3β-hydroxysteroid dehydrogenase (HSD), β-Ketoacyl acyl carrier protein synthase III (KAS III) (target enzyme for antibiotic resistant against the methicillin-resistant bacteria *Staphylococcus aureus*), New Delhi metallo-β-lactamase-1 (NDM-1) an enzyme present in *Escherichia coli* and the enzyme is a metallo β-lactamases classified in the B1 subclass which induces resistance to intravenously administered standard antibiotics [40]. Flavonoids have antibacterial properties acting by inhibiting DNA gyrase enzyme for both gram-positive and gram-negative bacteria [41].

### Alkaloids

Over twelve thousand alkaloids have been extracted from plants, categorized and they have a broad–spectrum of activity. The bacteriostatic activity of alkaloids can be attributed to different categories of alkaloids which include isoquinoline alkaloids, indole alkaloids, pyridine alkaloids and steroidal alkaloids. Alkaloids have also shown central nervous system depressant activity, antifungal activity, antiviral activity, antiprotozoal activity and anticancer activity. The various mechanisms of actions of alkaloids are linked to the unique chemical structures of these compounds, availability of proton accepting nitrogen atom and protons donating amine hydrogen atoms that aids formation of hydrogen bonds with proteins, receptors and enzymes. These mechanisms of actions include: inhibition of efflux pumps, damage of the cell membrane and cell wall, inhibition of ATP-dependent MurE ligase of *Mycobacteria tuberculosis*, modification of the bacterial cell membrane permeability, inhibition of bacterial metabolism, inhibition of the bacterial nucleic acid and protein synthesis, cell division inhibition, inhibition of RNA polymerase, inhibition of gyrase, DNA intercalation, inhibition of topoisomerase IA, inhibition of topoisomerase IV, and FtsZ (Filamenting temperature – sensitive mutant Z) protein inhibition [42-45].

### Steroids

Plant steroids are categorised based on their pharmacological activities, source and chemical structure. They have several pharmaceutical, medicinal and agrochemical properties which include but not limited to antibacterial activities, immunosuppression, anti-cancer activities, anthelminthic, cardiotonic activity, cytotoxicity, sex hormone and plant growth hormone regulator [46].

### CYTOTOXICITY

*Cassipourea malosana* (Rhizophoraceae) contains several phytochemicals. From the bark, three major arene compounds have been isolated including but not limited to methyl 4-ethoxy-2-hydroxy-6-propylbenzoate; 2α,3α-epoxyflavan-5,7,4′-triol-(4β → 8)-afzelechin and 2β,3β-epoxyflavan-5,7,4′-triol-(4α → 8)-epiafzelechin. Of the back extracts, flavan dimers containing methyl derivatives recorded higher activity against human ovarian cell line TOV21G while other bark extracts had little activity from the in vitro cytotoxicity evaluation with results ranging from $IC_{50}$ values of 30.3 µM to 75.4 µM [47].

### Toxic plants

There is an assumption that commonly used medicinal plants are safe. This is based on the fact that they have been used for centuries and the knowledge of their use has accrued over a long period of time. However, current studies show that majority of plants used either as medicinal plants or food have potential toxic effects, carcinogenic or mutagenic effects [34].

### Toxicity cellular viability assay

Human kidney epithelial cells used to assay toxicity cellular viability, with the aim of determining potential adverse effects during the administration of both the aqueous and organic plant extracts of *Cassipourea malosana* in the management of sexually transmitted infections. The study recorded the percentage (%) cell viability ± standard deviation for *Cassipourea malosana* as: 104.2 ± 0.78 for aqueous extract and 116.1 ± 0.82 for organic extract. Percentages reduction of more than 50% of the cells were considered toxic with a concentration of 100 µg/ml of the extract on the cells. Plant extracts causing an increase of 70 of the cells could potentially stimulate the cells and induce replication of the cells. Hence the *Cassipourea malosana* extracts were considered non-toxic [27].

## CONCLUSION

This review has revealed that plants continue to be a rich source of bioactive compounds with notable pharmacological activities attributed to their divergent phytochemical constituents and broad spectrum of pharmacological properties. This review focus on key findings on Pharmacology, Toxicology and Phytochemical Composition of *Cassipourea malosana* (Rhizophoraceae). However, despite their encouraging pharmacological activities, issues regarding safety and dosage standardization cannot be ignored. Therefore, future research should focus on evaluation of safe therapeutic doses, designing standardized drug formulations and utilization of technologies like bioinformatics and metabolomics to assist understating the mechanisms of action and support discovery of novel plant-based compounds which are safe for management of diseases.

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### Conflict of interest

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